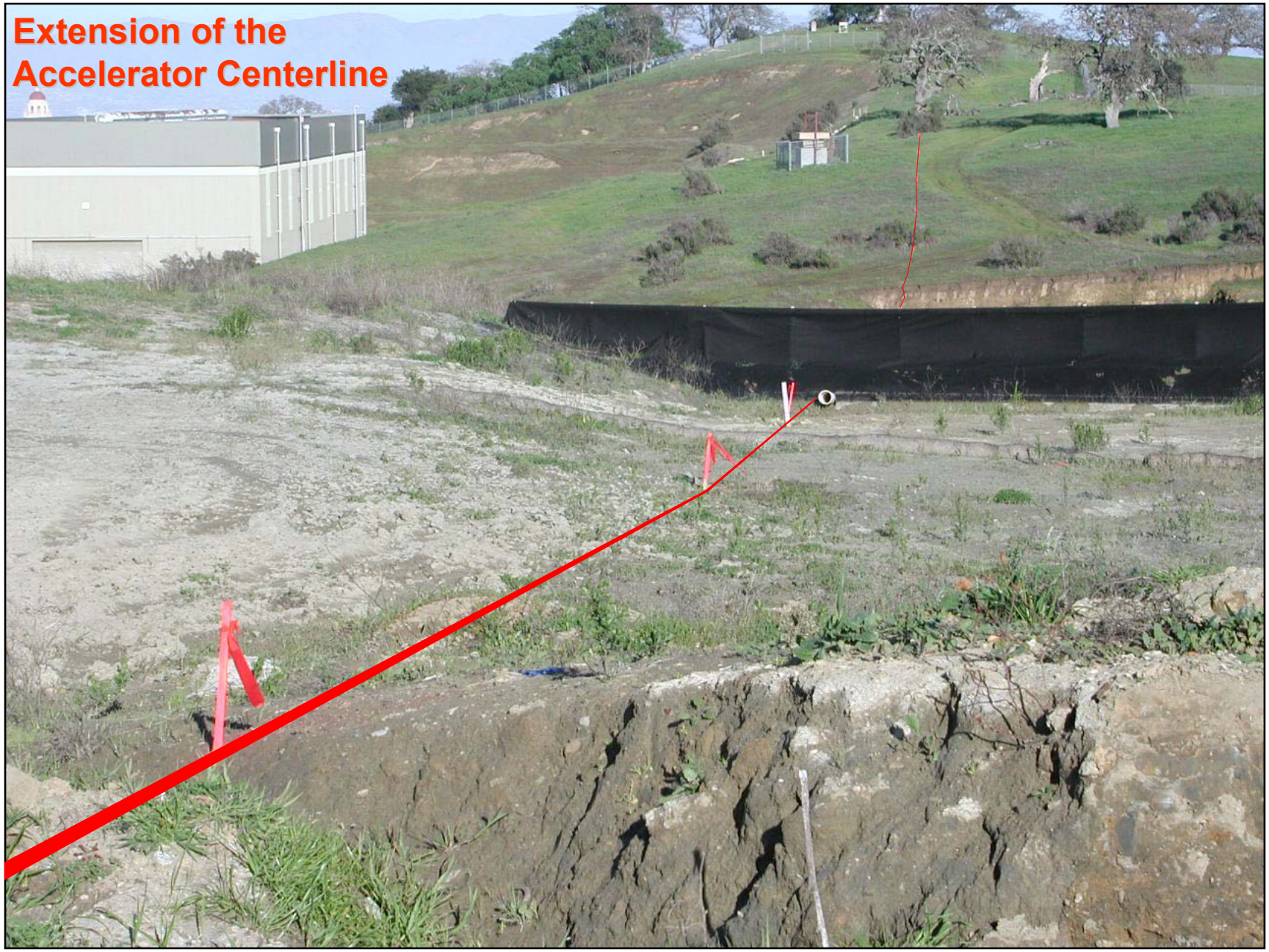
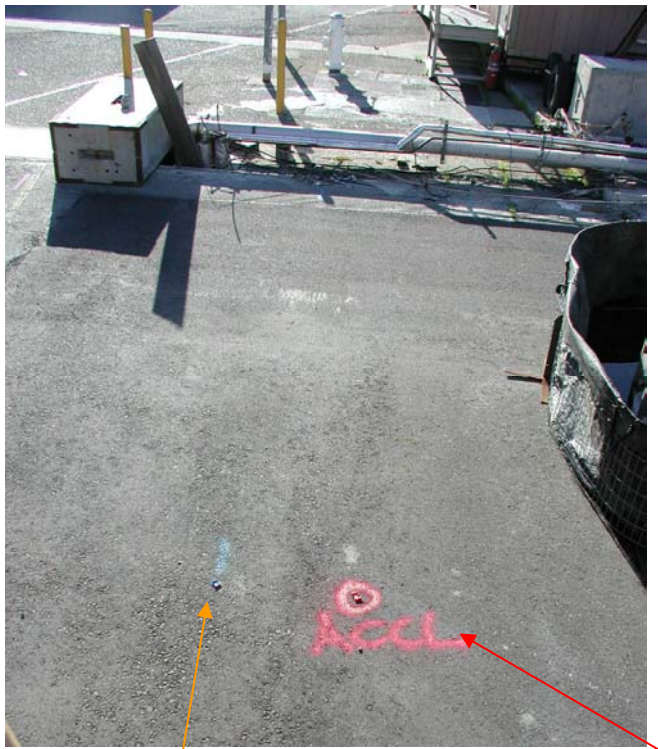

Extension of the
Accelerator Centerline

Sequence of Events

- Complete the marking of the accelerator line using the results of the previous 2 staked lines.
- Determine a full 2D transformation between the SLAC and the State Grid systems.
- Provide a first look at the profile along the accelerator line stake-out.

Part 1: Accelerator Line

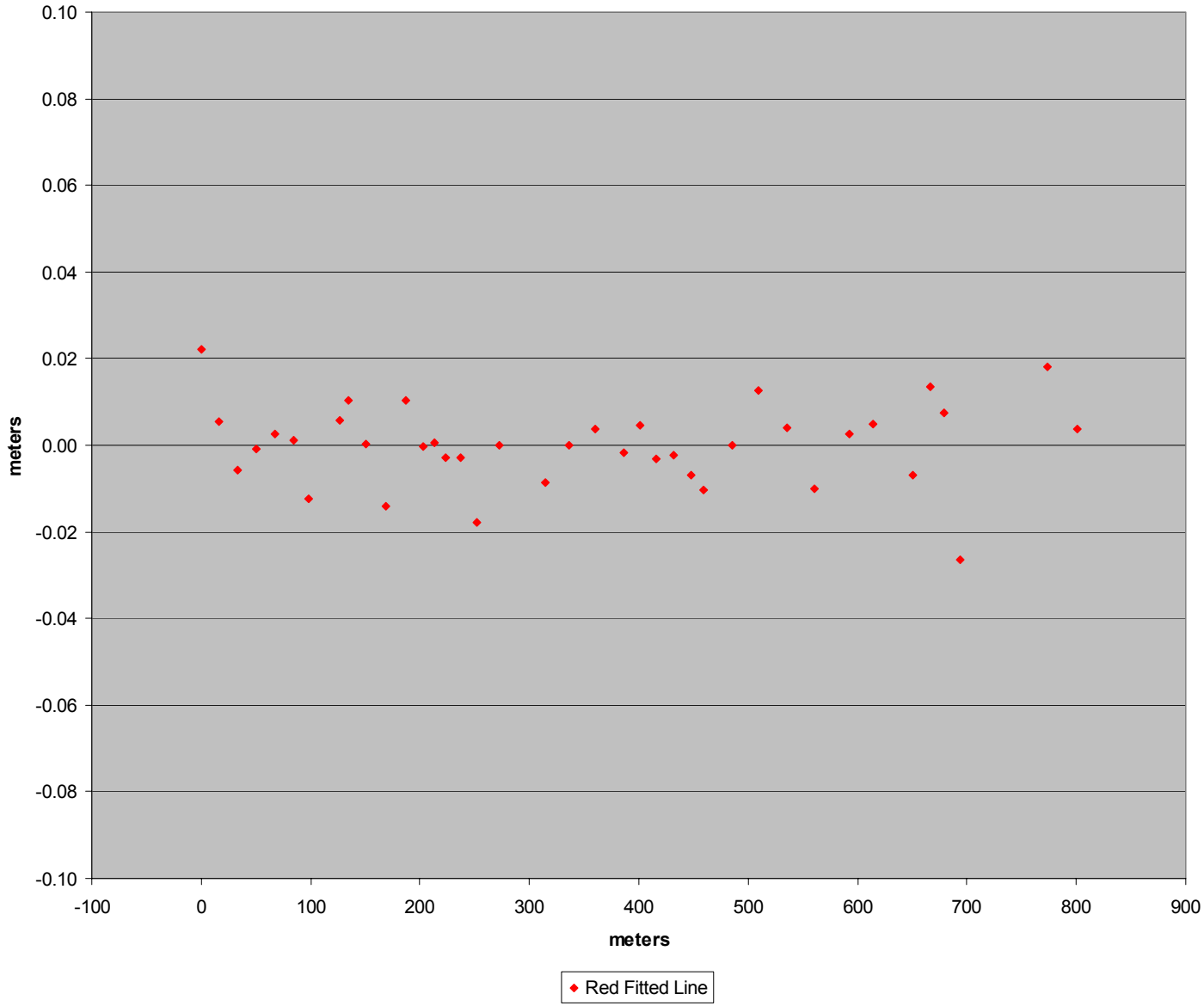


- Use the offsets computed from the orange line (blue painted line with orange stakes materializing the accelerator housing roof line) and stake the accelerator tube line using GPS/RTK.
- Best fit a line to all marks using same procedure as in the orange and purple lines.

Red Line: Accelerator Tube

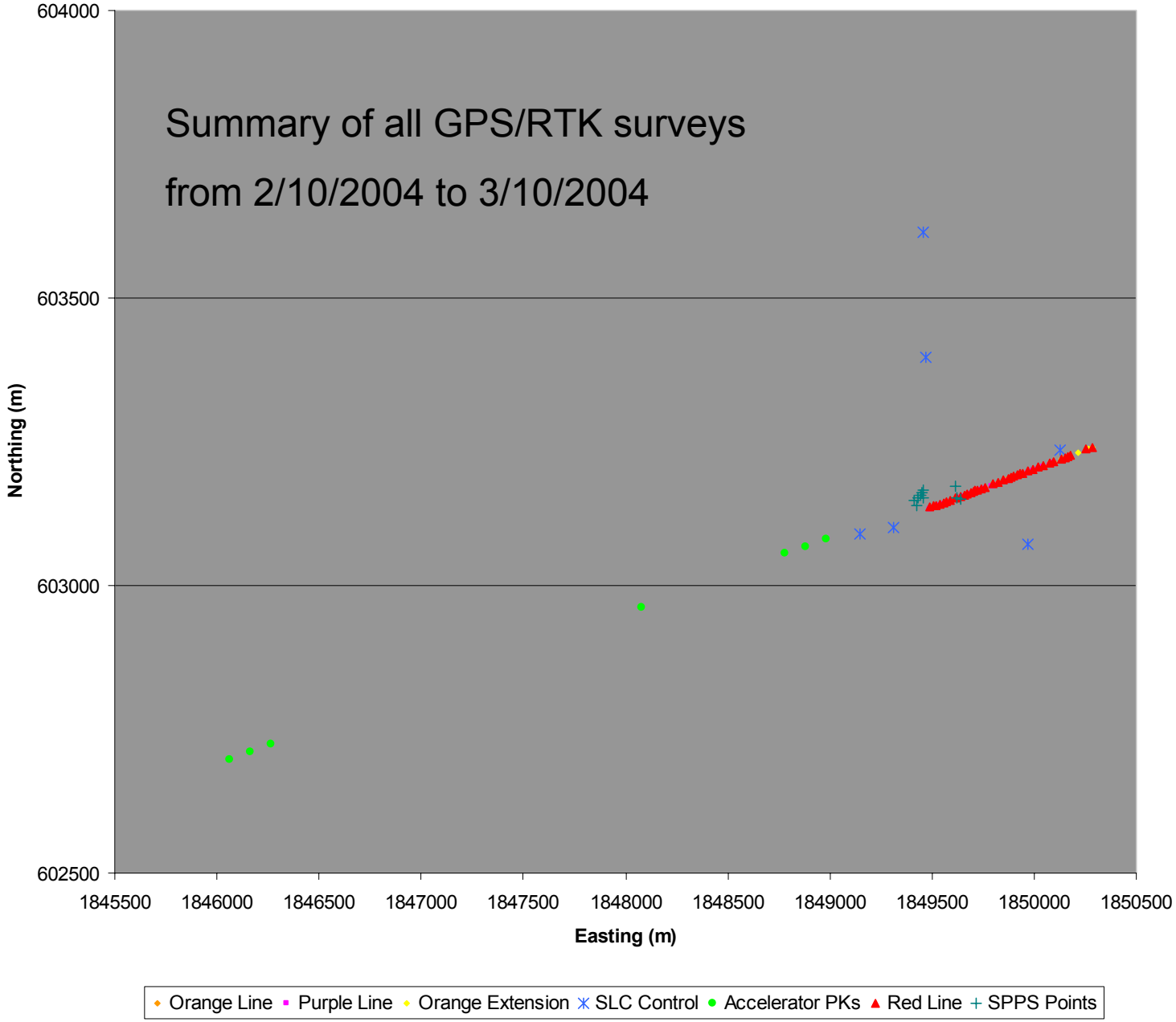
Orange Line: Linac Roof Centerline

Residuals to Accelerator Tube Best Fitted Line



Part 2: Datum Transformation

- The first measurement campaign concentrated only on direction stake-outs. The connection to the underground tunnel was obtained through 7 plates in the klystron gallery. It was checked with the SLC value of M20.
- To get a position along the line, other SLC monuments can be used for example. The first action is to gather quickly as many reliable points as possible. Then a model of transformation is chosen and its parameters derived from the common set of coordinates.


Summary of all GPS/RTK surveys
from 2/10/2004 to 3/10/2004
604000
603500
603000
602500
Northing (m)
1845500
1846000
1846500
1847000
1847500
1848000
1848500
1849000
1849500
1850000
1850500
Easting (m)
Orange Line
Purple Line
Orange Extension
SLC Control
Accelerator PKs
Red Line
SPPS Points

Datum Summary

	SLAC System	State Grid # 0403
Type	Cartesian	Geodesic
Use	Local	Regional
Origin	Station 100+00	Bo = 37.7510694363° N
		Lo = 120° 30' W
Offset	Z = 90000 m	Eo = 2000000.0000 m
	X = 70000 m	Nb = 500000.0000 m

2D Transformation Model between SLAC and State Grid

- Translation
  - Fix M40 in both systems.
- Rotation
  - Use the 7 PK nail observations.
  - Check with the 6 other observed SLC points.
- Scale
  - Use the scale factor at M40.
  - Check with the GPS derived distances from M40 to all other SLC points.

Common Points

- PK nails along the accelerator
  - Sectors 1, 2, 3, 21, 28, 29, 30
- SLC points
  - M40 base station
  - M32, M33, M36, M41, AAA
  - M20 (under metallic tower)
- SPPS points for checks only
  - SPPS010, 020, 040, 060, 070, 080 and 090

GPS/RTK Survey

Name	Easting (m)	Northing (m)
M32	1849466.507	603396.595
M33	1849454.877	603614.647
M36	1849967.040	603071.708
M41	1849308.806	603100.325
AAA	1850125.348	603234.659
M20 direct	1849618.606	603152.346
M20 average	1849618.597	603152.361

State Grid to SLAC

$$\begin{pmatrix} Z - Z_{M40} \\ X - X_{M40} \end{pmatrix} = k \begin{pmatrix} \cos\alpha & \sin\alpha \\ -\sin\alpha & \cos\alpha \end{pmatrix} \begin{pmatrix} E - E_{M40} \\ N - N_{M40} \end{pmatrix}$$

$Z_{M40} = 60.54993$ m

$E_{M40} = 1849150.024$ m

$X_{M40} = -2.41754$ m

$N_{M40} = 603088.745$ m

$\alpha = 7.498092°$

$k = 1.000055$

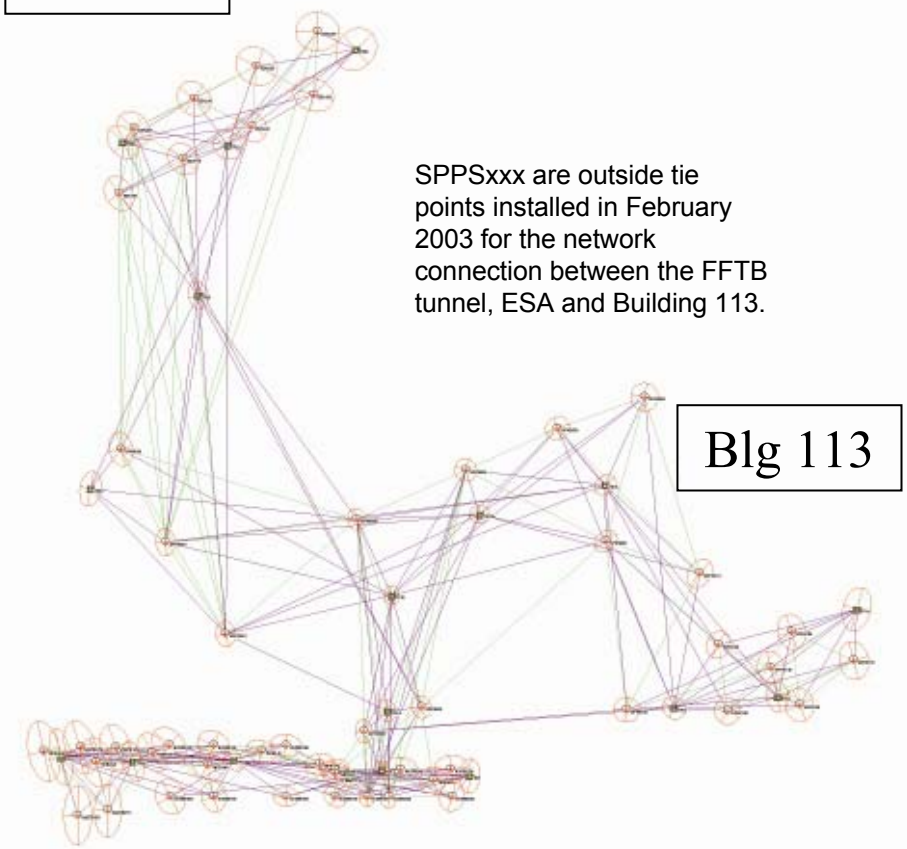
N.B. This model has been designed for general mapping purposes. It is a "cm transformation".
The scale factor k is now 1.000075 (3/3/2006) based on additional GPS observations.

Transformation Residuals

Name	DZ (m)	DX (m)
M32	-0.018	0.050
M33	0.000	-0.016
M36	0.030	-0.021
M41	-0.020	0.020
AAA	-0.038	0.058
M20 dir.	0.002	-0.020
M20avg.	-0.006	-0.004

Plate Sector	DX (m)
1	-0.001
2	0.012
3	0.011
21	0.002
28	0.003
29	-0.006
30	-0.001

ESA



SPPSxxx are outside tie points installed in February 2003 for the network connection between the FFTB tunnel, ESA and Building 113.

Blg 113

FFTB

Name	DZ (m)	DX (m)
SPPS010	-0.004	0.003
SPPS020	-0.002	0.002
SPPS040	0.001	0.017
SPPS060	0.004	-0.003
SPPS070	0.003	0.009
SPPS080	0.003	0.000
SPPS090	0.021	-0.008

SLAC to State Grid

$$\begin{pmatrix} E - E_{M40} \\ N - N_{M40} \end{pmatrix} = k^{-1} \begin{pmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{pmatrix} \begin{pmatrix} Z - Z_{M40} \\ X - X_{M40} \end{pmatrix}$$

$E_{M40} = 1849150.024$ m

$N_{M40} = 603088.745$ m

$Z_{M40} = 60.54993$ m

$X_{M40} = -2.41754$ m

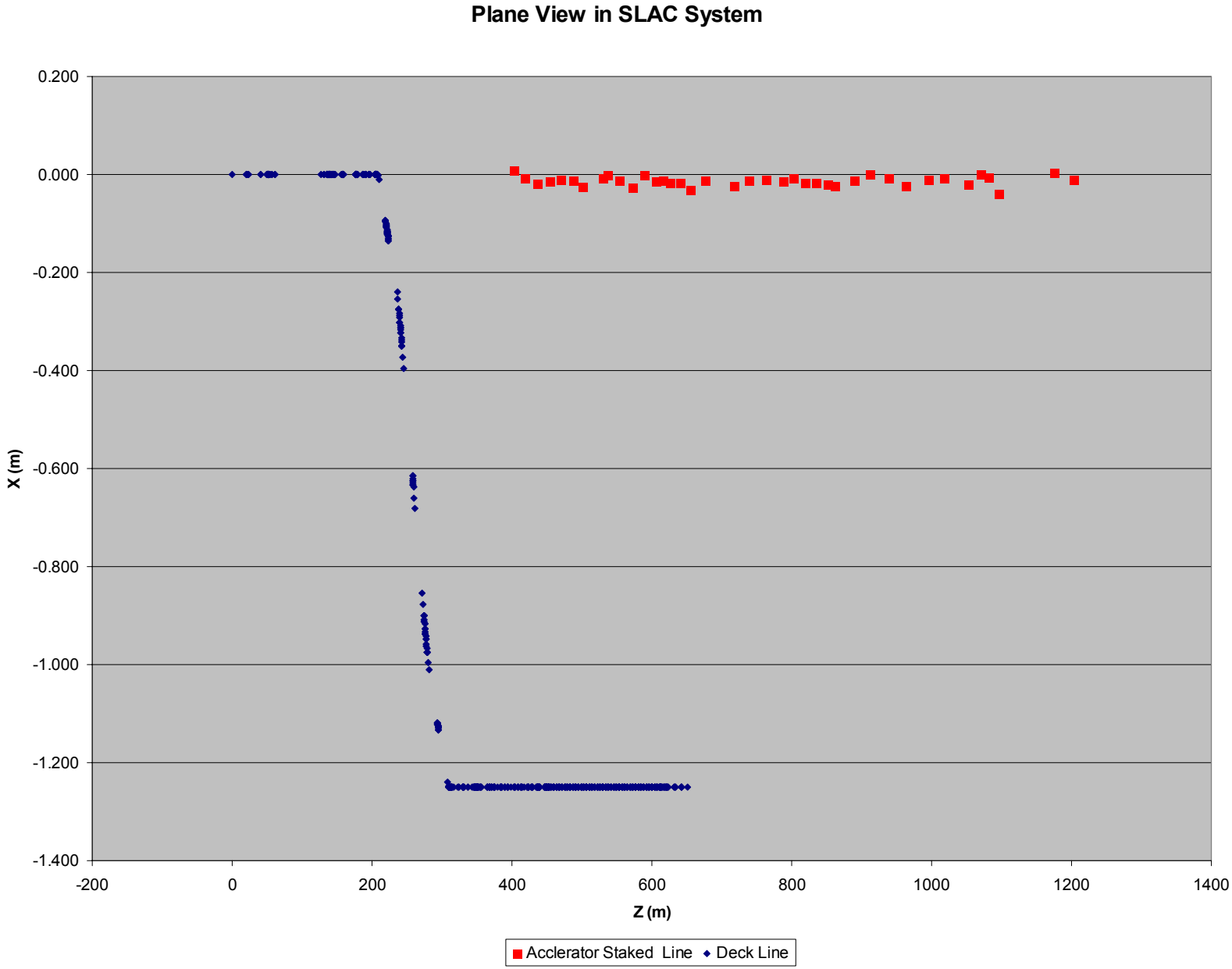
$\alpha = 7.498092°$

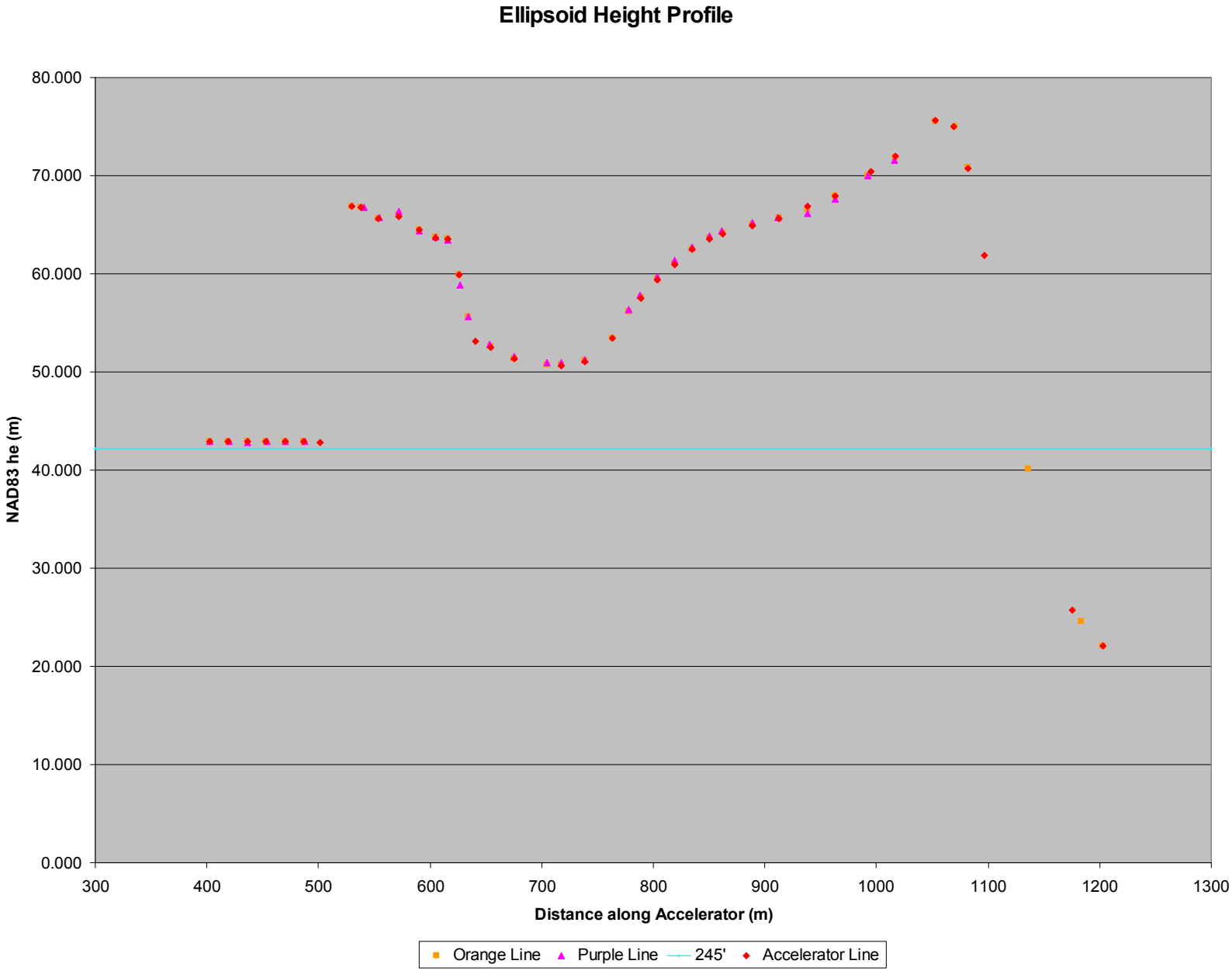
$k = 1.000055$

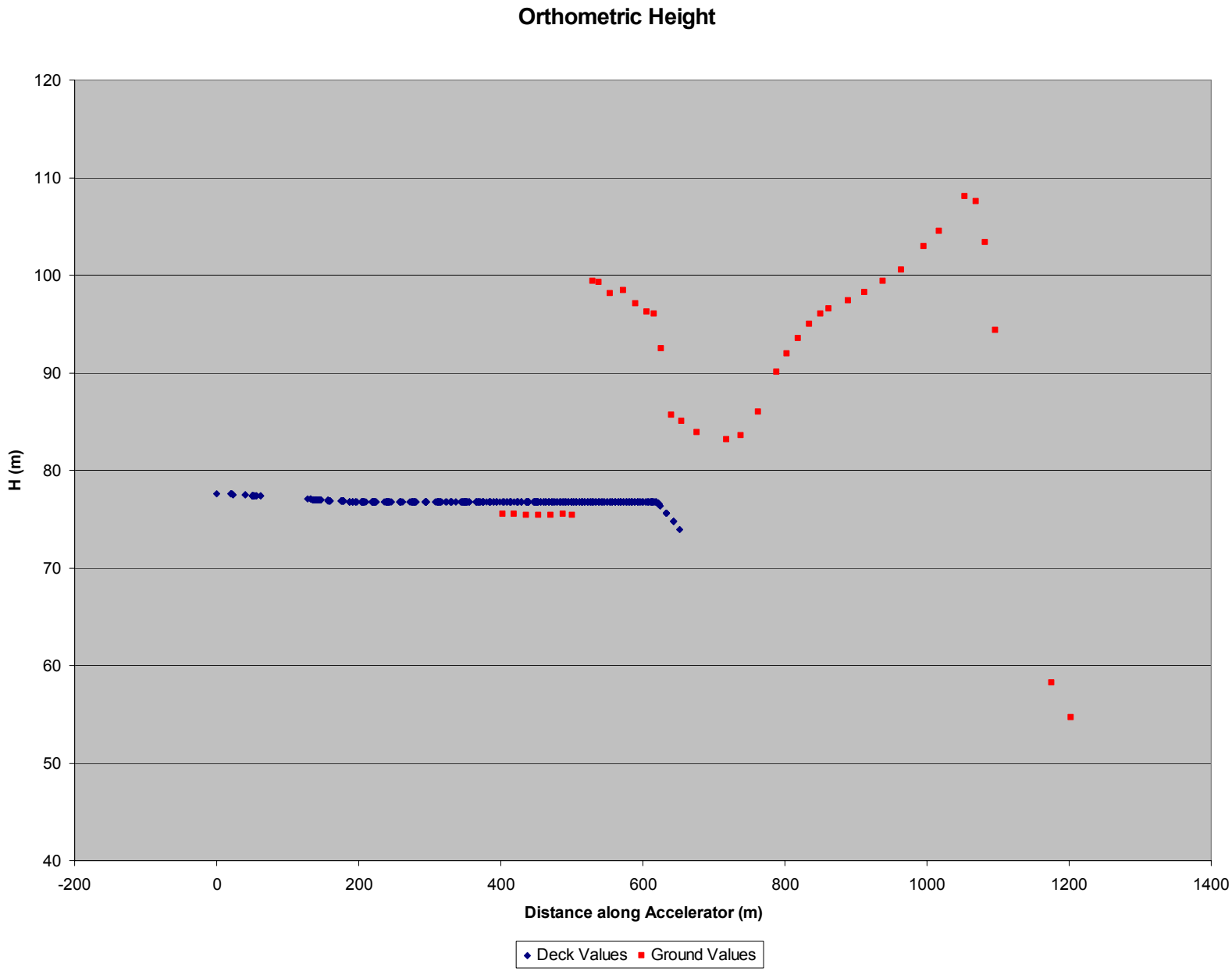
N.B. This model has been designed for general mapping purposes. It is a "cm transformation".
The scale factor k is now 1.000075 (3/3/2006) based on additional GPS observations.

Part 3: LCLS Line

- Now that a transformation between the SLAC and the State Grid systems has been defined, it is possible to put together deck values and outside measurements. One can also use this study to determine the location of the beginning and end of the bend. The current stake is after the bend.
- Preliminary profiles can be drawn along the staked lines. Note the agreement between the red, orange and purple profiles.


Plane View in SLAC System
0.200
0.000
-0.200
-0.400
-0.600
-0.800
-1.000
-1.200
-1.400
X (m)
-200
0
200
400
600
800
1000
1200
1400
Z (m)
Acclerator Staked Line
Deck Line


Ellipsoid Height Profile
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0.000
NAD83 he (m)
300
400
500
600
700
800
900
1000
1100
1200
1300
Distance along Accelerator (m)
Orange Line
Purple Line
245'
Accelerator Line


Orthometric Height
120
110
100
90
80
70
60
50
40
H (m)
-200
0
200
400
600
800
1000
1200
1400
Distance along Accelerator (m)
Deck Values
Ground Values

Conclusion

- Keep checking the transformation between the SLAC and the State Grid systems by observing and adding common points.
- Start a study on a geoid profile to allow a proper transformation between ellipsoid and orthometric heights. Right now, the transformation was based on GEOID 99. One can use GEOID 03. Over SLAC, it shows a simple shift versus its predecessor. For better results, one needs a specific study along the line.